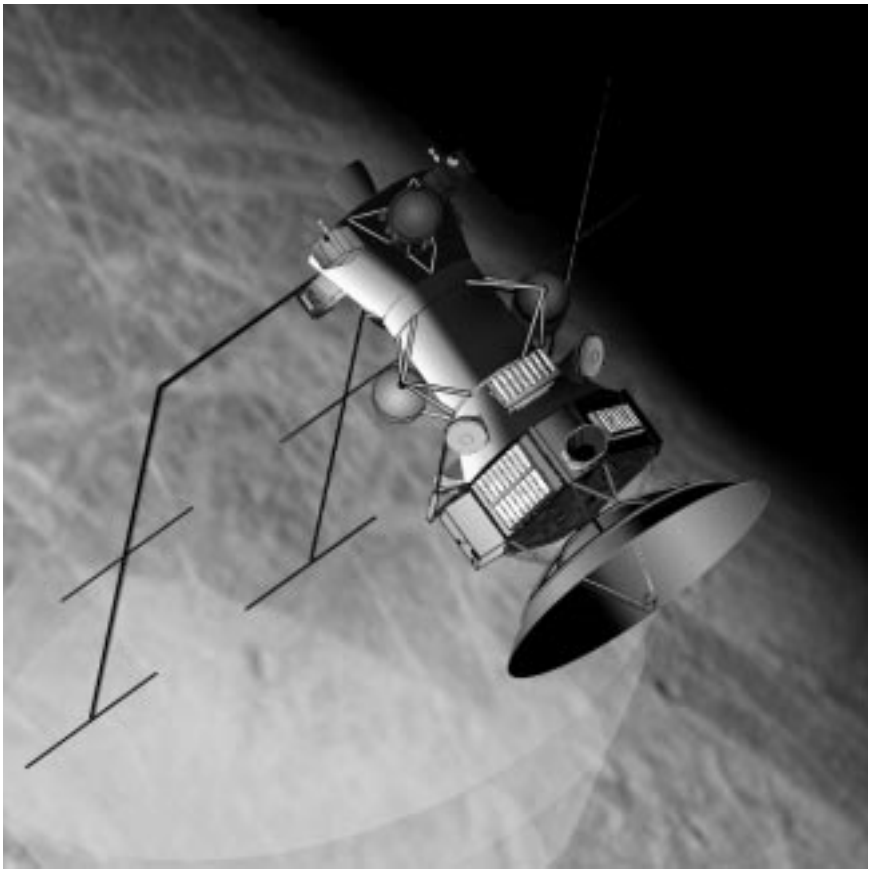
NASA Facts

National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109

Europa Orbiter

Europa Orbiter is a mission designed to study Jupiter's fourth largest moon, Europa, which has attracted immense interest because of indications that a liquid ocean may lie underneath its icy crust. If an ocean exists on Europa, that would greatly increase the odds that some form of life, however primitive, may have existed at some point in Europa's history.



The mission Europa Orbiter will seek to confirm the existence of a subsurface ocean and study its characteristics. Europa Orbiter is one of three missions being developed under NASA's Outer Planets/Solar Probe Project. The other two are Pluto-Kuiper Express and Solar Probe.

The Europa Orbiter spacecraft is currently under design using new technologies, especially those being developed by NASA's Advanced Deep Space System Development Program, also known by the nickname X2000. The X2000 program, managed at NASA's Jet Propulsion Laboratory, is designing modular spacecraft electronics, software and other components that can be reconfigured for various missions.

Following launch in 2003, Europa Orbiter will arrive at Jupiter's system in 2007 and enter orbit around Europa in 2009. The orbiter will use a number of techniques to learn more about Europa's ice and determine whether a subsurface ocean exists.

Science Instruments

Specific Europa Orbiter investigations will be selected by NASA during the next year. The scientific objectives of the prime mission are to:

- ❑ Determine the presence or absence of a subsurface ocean;
- ❑ Characterize the three-dimensional distribution of any subsurface liquid water and its overlying ice layers;
- ❑ Understand the formation of surface features, including sites of recent or current activity, and identify candidate landing sites for future lander missions.

Among experiments that have been suggested

to address these objectives are:

❑ **Measurements of Europa's tides**: If Europa's icy crust conceals a global subsurface ocean, Jupiter's huge gravity will raise large tides up to about 30 meters (about 100 feet), which will rise and fall every Europa day (about 3.5 Earth days). Precise measurements of the moon's gravity field and shape, using a laser altimeter, could detect these tides.

❑ **Mapping the surface**: High-resolution imaging of the surface from orbit can map most of Europa's surface, showing features smaller than a football field. This experiment would search for the youngest areas on the surface, define the moon's geologic history, and start looking for possible landing sites for future missions. Even higher-resolution pictures of small areas could be made.

❑ **Ice-penetrating radar**: Radar waves can penetrate through ice and, in fact, are used in Earth's Arctic and Antarctic regions to study the polar ice sheets. An orbiting radar "sounder" may be able to "see" through the ice in places and determine the thickness of the ice layers.

❑ **Other suggestions** which may be explored include mapping the composition of salts on Europa's surface and studying its electromagnetic properties. Electrical currents could be set up in a salty Europa ocean due to Jupiter's changing magnetic field.

Europa Orbiter is seen as a precursor mission for future "hydrobot" missions, which could use remote-controlled submarines to melt through the ice and explore Europa's ocean, should one be found. Therefore, Europa Orbiter will survey Europa for potential landing sites where the ice appears thin or where there are signs of current or recent activity.

Mission Overview

Europa Orbiter is currently scheduled for launch in November 2003. It is expected to launch on a Delta IV or Atlas V rocket, both of which are currently under development, or on a Space Shuttle mission. If launched on the shuttle, it would be released from the cargo bay and sent on its interplanetary flight path using a booster called an Inertial Upper Stage. Plans call for the spacecraft to fly directly to Jupiter without executing any “gravity assist” flybys of other planets on the way.

The spacecraft will arrive at Jupiter's system in late summer 2006, firing its engine to place the spacecraft in orbit around Jupiter. This initial orbit will last about 200 days. Just before it enters orbit around Jupiter, Europa Orbiter will pass by Jupiter's moon Ganymede, the gravity of which will help slow the spacecraft down.

The spacecraft will then tour Jupiter's system, executing about a dozen gravity-assist flybys of the other three largest moons of Jupiter -- Ganymede, Europa and Callisto. This tour is designed to use the gravity of these moons to gradually shrink the spacecraft's orbit. The tour is similar to that of NASA’s Galileo spacecraft, which has orbited Jupiter and its moons for more than three years, gathering a wealth of science data.

As a fringe benefit of its gravity-assist flybys, Europa Orbiter may be able to begin its Europa studies even before achieving Europa orbit. However, the bulk of the scientific studies will be conducted once the spacecraft is in orbit around Europa.

As the spacecraft's orbit shrinks and it approaches its final destination, the mission will mix close flybys of Europa with specially timed thruster firings to help reduce the approach velocity to Europa. In early to

Europa Quick Facts

Discovery: January 7, 1610 by Italian astronomer Galileo Galilei

Diameter: 3,138 kilometers (1,950 miles)

Mass (Earth=1): 0.0083021

Density (water=1): 2.97

Surface Gravity (Earth=1): 0.135

Mean Distance from Jupiter: 670,900 kilometers (about 417,000 miles), or 9.5 Jupiter radii

Mean Distance from Sun: 5.2 astronomical units (AU)

Orbital period: 3.5 days

Rotational period: 3.5 days

mid 2008, Europa Orbiter will arrive in orbit around the icy moon and begin its 30-day primary mission.

It is expected that this mission will consist of more than 300 orbits of Europa, with the objective of mapping the icy moon's entire surface. The orbiter will measure Europa's gravity field to look for the signature of tides induced by Jupiter.

Spacecraft Design

The Outer Planets/Solar Probe Project's design teams are now studying various options for the Europa Orbiter craft, which must be designed to withstand severe radiation in Jupiter's system, the most intense radiation environment in the solar system. Spacecraft designers are developing creative configurations for self-shielding of the spacecraft.

While the Galileo spacecraft was designed to withstand severe radiation, Europa Orbiter is being designed to withstand about seven times the radiation dose endured by Galileo. Europa Orbiter will receive a vastly higher radiation dose than Galileo because it will spend a long time at Europa's distance from Jupiter, within the high-radiation inner Jovian system. It will experience most of this radiation dose during the final three months before arrival and during its orbital mission around Europa. Galileo, on the other hand, was built with much heavier shielding and spent most of its time far outside the inner Jovian system.

Europa will stay within a development budget of less than $300 million, as part of NASA's new philosophy of "faster, better, cheaper" missions launching low-cost spacecraft with highly focused science goals.

Several enabling technologies are needed and are currently under development by the X2000 program and the Outer Planets/Solar Probe Project in conjunction with JPL's Telecommunications and Mission Operations Directorate. Europa Orbiter will use electronics currently being developed under the X2000 program. Software is being designed to facilitate onboard decision-making and fault protection for a series of quick spacecraft maneuvers during the phase of the mission just before the spacecraft enters orbit around Europa.

Europa Orbiter will have a maximum lifetime of six years. Although studies of solar panels are ongoing, a mission power requirement of more than 200 watts may require the use of an advanced radioisotope power source (ARPS) and a secondary battery system. The ARPS is a new-generation power source that takes the heat naturally given off by plutonium and converts it into electricity. The ARPS is being developed by the U.S. Department of Energy.

As another critical part of spacecraft design, engineers must reduce the weight of the onboard propulsion subsystem as much as possible. Europa Orbiter will use a bipropellant propulsion subsystem using hydrazine as fuel mixed with with nitrogen tetroxide as the oxidizer. During the course of the mission, the orbiter's engines will change its speed by about 2,300 meters per second (5,145 miles per hour).

The telecommunications system will operate in either the X-band or Ka-band range of the microwave spectrum.

The spacecraft will be able to point its instruments to within 5 milliradians (about 1/4 of a degree), or the apparent diameter of a dime at a distance of four yards.

Europa

Europa is the smallest of Jupiter's four major moons, which also include Callisto, Ganymede and Io. Nonetheless, Europa is the sixth largest natural satellite of any planet in the solar system. With a diameter of 3,138 kilometers (1,950 miles), Europa is slightly smaller than Earth's Moon.

Europa’s surface is very bright and consists of two types of terrain. One type is mottled, brown or gray in color, and consists mainly of chaotic terrain with iceberg-like hills frozen in it. The other type consists of large, smooth plains criss-crossed with numerous ice ridges, some curved and some straight. Some of these ridges run thousands of kilometers (or miles) in length. Europa's "crust" of ice and water may be about 100 to 150 kilometers (about 60 to 90 miles) thick, but it is unknown how much of this, if any, is liquid water.

Although Europa was not observed as extensively as Jupiter’s other moons when NASA's Voyager 1 and 2 spacecraft flew past the planet in 1979, pictures taken by Galileo in the mid-1990s show dramatic new evidence of possible liquid oceans under the crust. Chunks of ice, resembling icebergs seen in Earth's Arctic Ocean, appear to be frozen in place in large

disrupted areas on Europa's surface. The tidal effects of Jupiter and its other moons, as well as heat released by radioactive elements in Europa's mantle and core, might provide heat sources which could maintain a liquid water ocean beneath the ice and perhaps even produce volcanoes under the ice.

Europa is the smoothest object in the solar system, with nothing exceeding one kilometer (about 3,300 feet) in height. Because there are very few impact craters, many scientists interpret this as evidence that the surface may be as young as only 30 million years old. Europa's inner core is probably made of iron-sulfur, and its tenuous atmosphere is composed primarily of molecular oxygen.

More information on Europa Orbiter is available from the project's home page at:

http://www.jpl.nasa.gov/pluto/europao.htm

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